

REMARKS

Claims 1 – 18 are now pending in the application, with claims 11 – 16 having been withdrawn. The Examiner is respectfully requested to reconsider and withdraw the rejection(s) in view of the amendments and remarks contained herein.

REJECTION UNDER 35 U.S.C. § 103

Claims 1 – 10 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Scherer et al. (U.S. Pat. No. 5,888,204) in view of Komurasaki (U.S. Pat. No. 5,119,783). Applicants respectfully traverse this rejection.

Scherer et al. is directed to a device for determining the engine load for an internal combustion engine. In the Official Action mailed March 2, 2005, the Examiner cited Scherer et al. as suggesting a method/system of detecting misfire in an engine that detects engine speed fluctuations (citing to col. 3, lines 1/2 of Scherer et al.), determining a linear model based on the engine speed fluctuations (citing to col. 4, lines 48 – 51 of Scherer et al), and applying a Kalman filter to the linear model to determine parameters of the linear model (citing to col. 2, lines 1 – 12 of Scherer et al.). Acknowledging that “Scherer et al. fail to teach detecting a misfire (engine firing) based on the linear model,” the Examiner takes the position that it would have been obvious to one of ordinary skill in the art to do so based on the teachings of Scherer et al. The Examiner takes the position that the motivation to do so is that Scherer et al. “teaches that the object of their device is to determine an engine load even during non-steady-state operation (col. 2, lines 61 – 65) wherein non-steady-state operation is caused by vibrating piston travel movement (col. 1, lines 34 – 40), and because vibrating piston travel movement is well known to include engine firing events such as misfire event. The Examiner then cites to Komurasaki (5,119,783) as a teaching reference to demonstrate such a relationship.

Applicants submit Scherer et al.'s use of a Kalman filter to determine engine load using engine speed as an input does not disclose or suggest detecting engine misfires, let alone doing so by the methods claimed in independent claims 1, 6 and 7. Scherer et al.'s technique estimates engine load using engine speed as an input. But Scherer et al.'s technique does not determine why the engine load changed. For example, if a

driver "floors" the gas pedal to pass a slow moving car, this causes the engine load and speed to change drastically, and Scherer et al.'s device would estimate the change in the engine load using the engine speed as an input. But his technique would not determine that the change was caused by the driver "flooring" the gas pedal, it would just determine that engine load changed based on the change in engine speed.

In this regard, knowing engine load provides little in the way of detecting engine misfire. As is known, every modern automobile engine has sensors to detect engine loads, such as the mass airflow sensor, the throttle position sensor and the manifold pressure sensor. Scherer et al. teaches a refinement of engine load determination above and beyond these sensors. But Scherer et al. does not disclose or teach determining what caused the engine speed, and thus the engine load, to change. And in most cases, it will be events other than engine misfires that cause the engine speed to change, such as the driver pressing or releasing the accelerator, the vehicle going up or down a hill, or the like. In contrast, applicants' invention as claimed in claim 1 is directed to detecting that an engine misfire occurred using engine speed fluctuations as an input. It does so despite engine loads. Misfire detection is not a natural extension of engine load determination as misfire can occur under varying engine load conditions.

The teaching in Scherer et al. that the object of their device is to determine an engine load even during non-steady state operation, upon which the Examiner relies, means just that. One cannot assume that just because Scherer et al. teaches determining engine load, even during non-steady-state operation, that it also teaches what caused the non-steady-state operation. That vibrating piston travel movement is one event that causes non-steady-state operation, and thus a change in engine load, does not mean that it is the only event that causes non-steady-state operation. And that engine misfire may cause vibrating piston travel movement does not mean that engine misfire is the only cause of vibrating piston travel movement. As recognized by Komurasaki, to detect engine misfire from engine vibrations, the vibrations must be low-pass filtered and misfire detected only when a low-frequency component of the vibrations exceeds a prescribed reference level. [Komurasaki, Abstract]

Applicants' invention is based on the mechanism that a misfire occurrence directly results in fluctuation of engine speeds. From these fluctuations in engine

speed, misfire is detected by the use of a linear model and a Kalman filter is used to estimate parameters of the linear model. More specifically, independent claim 1 is directed to a method of detecting misfire in an engine. It requires detecting crankshaft speed variations in the engine, determining a linear model for estimating engine firing event based on the crankshaft speed fluctuations, applying a Kalman filter to the linear model to determine parameters of the linear model, and detecting a misfire event in the engine based on the linear model. Independent claim 6 is also directed to a method of detecting misfire in an engine. It requires detecting crankshaft speed fluctuations in the engine, determining a linear model for estimating engine firing events based on crankshaft speed fluctuations, representing the linear model as a difference equation, estimating parameters of the difference equation at a Kalman filter to determine a firing event model, and detecting a misfire event in the engine based on the firing event model. Independent claim 7 is directed to a misfire detection system that detects misfire in an engine. It requires a sensor that determines speed fluctuations of the engine, a controller that determines a firing event model for estimating engine firing events based on the speed fluctuations of the engine and applies a Kalman filter to the model to estimate parameters of the model, and a misfire detector that detects a misfire event based on the model. For the reasons discussed above, applicants submit that Scherer et al. fails to disclose or suggest these limitations.

Similarly, Komurasaki fails to disclose or suggest the foregoing limitations. Komurasaki uses a vibration sensor and determines that engine misfiring occurred when the level a low frequency component of the vibration exceeds a prescribed reference level. Komurasaki is thus directed to a much different technique of detecting engine misfiring by using vibration that is detected with a vibration sensor. In contrast, applicants' invention uses fluctuations in engine or crankshaft speed to detect engine misfiring. It does so by determining a linear model for estimating engine firing events based on engine speed fluctuations, applies a Kalman filter to the linear model to determine parameters of the linear model, and detects misfire based on the linear model.

In an embodiment, applicants' invention utilizes an inverse linear model of a linear model of engine crankshaft speed. This is now required by new claim 17, which depends from claim 3.

New claim 18, which depends from new claim 17, requires that the difference equation take the form $y(k) = b_0 N(k) + b_1 N(k-1) + \dots + b_m N(k-m) + v(k)$ where b_0, \dots, b_m are the model parameters and N is the engine speed at sample $k, k-1, \dots, k-m$, where k and m are integers. Thus, the model equations required by claim 18 to be applied to the Kalman filter are different than the ones applied to the Kalman filter of Scherer et al.

Claims 2 – 5 depend directly or indirectly from independent claim 1 and claims 8 – 10 depend directly or indirectly from independent claim 7, and are thus allowable for at least these reasons.

CONCLUSION

For the reasons set forth above, applicants submit that claims 1 – 10, 17 and 18 are allowable and respectfully request the early notice of their allowance.

Respectfully submitted,

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